

THE VEHICLE ROUTING PROBLEM WITH TIME-VARYING TRAVEL TIMES AND A SOLUTION METHOD

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ABSTRACT. *A variant of the vehicle routing problem, which considers time-varying travel times between locations, has many real-life applications. It is shown that the problem cannot be solved to optimality even for very small instances. With respect to the additional computational efforts, the benefits gained in terms of reduction in total routing cost through considering the time-varying property of the travel times is investigated. For this end, a genetic algorithm is proposed and experimental tests are conducted. It is found that although the time-varying property significantly increases the computational complexity, careful choice of constraints handling method and replacement strategy can improve the performance of the algorithm. It is also shown that the benefits gained in terms of objective value through considering the time-varying property of travel times is significant.*

Keywords: Vehicle routing problem, Time-varying travel time, Genetic algorithm

1. Introduction. The vehicle routing problem (VRP) has received much interest among researchers due to its widespread applications. The traditional VRP models assume constant travel times between locations, which is not realistic particularly in urban areas. For example, the traveling times during the morning and evening rush hours are greater than those in other time of the day. In recent years, advanced traffic information systems have been implemented in many cities and can provide more accurate information on traffic conditions in the cities, including the time varying patterns of the travel times. Considering the time-varying property in solving the vehicle routing problem could be beneficial for improving the quality of the routing plan.

However, the time-varying property of travel times may significantly increase the computational complexity of the traditional vehicle routing problem, which is already *NP*-hard. Highly efficient heuristic or meta-heuristic methods are required for obtaining near-optimal solutions. The benefits gained from considering the time-varying property of travel times would be reduced by the increased complexity of the problem. The aim of this paper is twofold. The first is to propose a genetic algorithm and investigate the performance of the algorithm on solving the VRP with time-varying travel times. The second is to investigate the benefits gained through considering these time-varying travel times with respect to the additional computational efforts.

The remaining part of this paper is organized as follows. Section 2 reviews the related literature. In Section 3, the vehicle routing problem with time-varying travel times is defined and a mixed integer linear programming model is discussed. In Section 4, a genetic algorithm is devised. In order to improve the adaptation of the algorithm, different